REMARKS/ARGUMENTS

In the Office Action, the Examiner noted that claims 1-22 are pending in the application. The Examiner additionally stated that claims 1-22 are rejected. By this amendment, claims 1, 9, and 14 have been amended. Hence, claims 1-22 are pending in the application.

Applicant hereby requests further examination and reconsideration of the application, in view of the foregoing amendments.

In the Specification

Applicant has amended the specification to secure a substantial correspondence between the claims amended herein and the remainder of the specification. No new matter is presented.

In the Claims

Rejections Under 35 U.S.C. §103(a)

The Examiner rejected claims 1-22 under 35 U.S.C. 103(a) as being unpatentable over Mittal et al., U.S. Patent No. 5719800 (hereinafter, Mittal), in view of Brock et al., U.S. Patent No. 6,836,849 (hereinafter, Brock), and further in view of Browning, U.S. Patent No. 6415388 (hereinafter, Browning). Applicant respectfully traverses the Examiner's rejections.

With reference to claim 1, the Examiner noted that Mittal teaches the apparatus including:

- a plurality of functional units each including a corresponding plurality of activity outputs, for indicating when a respective functional unit is enabled [105 and 501, figs. 1 and 5 and col. 5, lines 40-43]
- utilization assessment logic, coupled to said plurality of activity outputs, for assessing activity thereof to determine a current total power consumption value for the microprocessor [col. 5 lines 30-42 and col. 11 lines 54-58]. (The Examiner at this point conceded that Mittal explicitly teaches that temperature, when used as an activity indicator, allows power consumption to be monitored.)

- power control logic, coupled to said utilization assessment logic, for comparing said current total power consumption value with a threshold power value included in a specified power profile, wherein a select signal directs said power control logic to select said specified power profile from a plurality of profiles that are store within said power control logic [col. 5 lines 30-42 and col. 11 lines 54-58]. The Examiner parenthetically remarked that although a select signal is not explicitly taught, Mittal teaches engaging one of a plurality of power modes (i.e., power profile) in response to the utilization (i.e., power consumption) being greater or less than a threshold value, and that in order to trigger this response, it is obvious if not inherent that a signal would have to be generated in order to select the appropriate power mode. The Examiner added that in addition, because the mode controller (107/502) initiates the change between a normal and reduced power mode without any explicit teaching of loading the power mode settings (i.e., power profile) from outside the mode controller, it is interpreted that the power profiles selected by the power control logic are selected from profiles stored within the power control logic.
- a power consumption controller, coupled to said power management logic and said plurality of functional units, for engaging one of a plurality of power reduction modes if said current total power consumption value exceeds said threshold power value [abstract and col. 5 lines 25-29]. The Examiner added that because the activity monitor and mode controller compare the power consumption value with a threshold value, selects a power mode in response to the comparison and engages that power mode, it is interpreted that the activity monitor and mode controller comprises the utilization assessment logic, power control logic and power consumption controller as they perform the same functions.

The Examiner stated that although Mittal teaches using a measured temperature to represent the activity level for the purpose of monitoring power consumption, it is unclear as to whether or not the temperature is measured at each functional unit which would then be output as current activity information to their respective activity monitors, or if the temperature is measured at a central location to determine the "overall power." The

Examiner added that because Mittal is concerned with independent control over each functional unit [fig. 5 and col. 11 lines 22-25 and 34-36], one would believe that the temperature would be measured at each functional unit in order to maintain individual control over "a particular functional unit 501" but suggesting that measuring a substrate temperature to determine "overall power" [col. 5 lines 40-41] seems to suggest otherwise. The Examiner then opined that Brock teaches measuring temperature both globally and at individual processing elements for the purpose of controlling the processing elements individually or as a whole [col. 4 lines 4-14 and col. 7 lines 7-14]. Thus, the Examiner concluded that it would have been obvious to one of ordinary skill in the art at the time of the invention to have each functional unit output its own temperature (i.e., current activity information) to their respective activity monitors, because it would allow the Mittal system to maintain independent control of the functional units while still limiting operation of each functional unit based on availability of power heat generation, etc., as taught by Brock [abstract].

The Examiner also conceded that Although Mittal implicitly teaches a select signal for selecting between power modes, it is not explicitly taught to have a select signal for selecting one of a plurality of power reduction modes to be engaged if the current total power consumption value exceeds said threshold power value, but that Browning teaches selecting a power mode from a plurality of power modes including a plurality of power reduction modes [figs. 6 and 7 and cols. 5-7 lines 64-8]. To summarize, The Examiner stated that Browning teaches having multiple temperature thresholds and initiating a power mode based on the current temperature noting, for example, when the temperature or power consumption of a processor is below threshold Tl, the processor enters a first high power/performance state, and when the processor temperature or power consumption is above threshold Tl but below threshold T2, the processor enters a second power/performance state that is lower than the first high power/performance state. Finally, the Examiner stated that if the temperature or power consumption of the processor is above threshold T2, the processor enters a power/performance state that is even lower than the second power/performance state.

Accordingly, the Examiner concluded that it would have been obvious to one of ordinary skill in the art to include the plurality of reduced power states and to generate a selection signal to select one of the reduced power states to be engaged, by power control logic and power consumption controller (i.e., activity monitor and mode controller), because it would obviously introduce varying degrees of performance throttling based on necessity, thus optimizing system performance. In particular, the Examiner opined that supplying just a single lower power mode does not optimize system operation, noting that if running a processor at a maximum rate and the temperature begins to overheat just slightly, an aggressive power reduced mode may not be necessary, and by including a reduced power mode that is not as aggressive, power consumption and temperature can be reduced while still providing substantial performance. The Examiner noted on the other hand if running the same processor at the same maximum rate and the processor begins to experience substantial overheating, the same aggressive power reduced mode would be necessary to rapidly reduce the temperature and power consumption at the expense of performance to prevent imminent damage to the processor circuitry, and by providing varying degrees of performance, the system can maintain optimal performance given its current operating environment.

Applicant respectfully disagrees with the Examiner's rejection of claim 1 for the following reasons.

First, it is respectfully submitted that if it were the purpose of the present invention to measure and control the *temperature* of a microprocessor, or of functional units within a microprocessor, then perhaps one or more of the references submitted by the Examiner may have merit. However, as stated in paragraph [0008] of the instant disclosure, temperature control of a microprocessor is not an object of the present invention. Rather,

> *. . . what is needed is a microprocessor in which the utilization of power by individual functional units within is determined to a fine degree of resolution so that power consumption can be more accurately controlled and managed.*

And as one skilled in the art will concur, the incremental temperature of a specific functional unit may be estimated as a function of the substrate temperature—measured in

degrees--and of the power consumed—measured in Watts--by the functional unit, the converse of this statement is does not follow. That is, the power consumed by a functional unit cannot be indicated based upon knowledge of its temperature.

Applicant respectfully asserts that both the Mittal reference and the Brock reference speak to temperature control. The techniques taught for both measuring and controlling are directed to control device temperature. Applicant also respectfully points out that integrated circuit designers sometimes use the terms "power" and "temperature" in a manner that appears to equate the two parameters, and this is because they are more or less correlated depending upon the environment in which they are used. However, it is offered that the direct teachings of Mittal and Brock speak to temperature measurement and to various techniques for controlling device temperature, where one or more of these techniques involve a reduction in power consumption, because a reduction in the power consumption of an element within a device does necessarily correspond to a reduction in device temperature.

But this is not what Applicant is addressing, and specifically this is not what is claimed. More specifically, claim 1 recites, *inter alia,* "wherein the value said activity output indicates how much power said respective functional unit is consuming." This limitation is supported in various places in the instant disclosure, including paragraph [0026]. In numerous tables in the instant specification, "how much power" is expressed in its proper unit of measure—Watts. It is respectfully submitted that when one measures temperature, the unit of measure is of the various forms that are used to quantify heat as opposed to power consumption. Mittal measures temperature, and, as the Examiner has noted, Brock's parameters are specified as those used to quantify heat.

In traversal of the Examiner's assertion that Mittal explicitly teaches that temperature, when used as an activity indicator, allows power consumption to be monitored, Applicant respectfully offers that such a statement is not accurate, and submits that Thevin and Norton circuits are equivalent, however, heat is dissipated by the Norton circuit. Hence, power consumption may be inferred from a temperature measurement, but how much power that is being consumed cannot be indicated.

Applicant also wishes to point out that the Examiner's parenthetical equivocation between Mittal's utilization to power consumption) being greater or less than a threshold value is substantially the same misuse of the terms as is allude to above. That a unit is utilized more or less does not indicate how much power is being consumed by that unit.

At a high level, Browning teaches a technique for controlling device temperature as well, but one of his embodiments (Fig. 4) employs a resistor on chip to measure overall device power consumption. Nevertheless, Browning's objective is to control device temperature by controlling device power consumption.

Consequently, none of the noted references are geared toward a fine control of device power consumption. None of the noted references provide an activity output from a function unit whose value indicates the power consumed by the functional unit. And taking the three references in combination, one skilled in the art will be motivated to perhaps employ multiple temperature sensors within a device to detect hot spots, and to employ extant profiles under which the device is to operate, where these profiles may involve *temperature* reduction mechanisms such as frequency stepping, voltage stepping, etc.

Applicant respectfully asserts that, alone or in combination, the cited references are utterly silent with regard to the above-noted limitation.

As noted in the previous response, Mittal does not measure the power consumed by a functional unit, but rather monitors an activity level of the unit and infers power consumption therefrom. For example, Mittal's activity monitor tracks the recent utilization of a particular functional unit within the IC by, for example computing its average duty cycle over its recent operating history. (col. 3, lines 18-22) Mittal proposes profiling the power consumption of sequences of operations in a mix of popular software programs, and choosing from among those sequences the sequence with the highest power consumption. (col. 4, lines 49-57) This is the sort of coarse power estimation technique that the present inventor has noted is disadvantageous and for which the present invention is proposed to overcome. Clearly, Mittal does not teach an activity output whose value indicates how much power a functional unit is consuming.

Regarding Brock, it is submitted that the inventor teaches how to control certain aspects of individual processors in a multiprocessor system (i.e., a rack) to achieve performance goals. More specifically, Brock teaches measuring temperatures, acoustic noise levels, etc. But he does not teach, suggest, or imply an activity output of a functional unit whose value indicates how much power the functional unit is consuming.

As per Browning, Applicant respectfully asserts that the inventor only teaches selecting a power mode from a plurality of power modes including a plurality of power reduction modes, and these are employed as a function of device temperature. However, Browning provides no motivation whatsoever to support indicating the power consumed by a functional unit via the value of an activity signal, as is provided for in claim 1. Moreover, the combination of Mittal and Browning fails to teach, suggest, or even hint that a functional unit may provide an activity signal that indicates the power that it is consuming, thus providing for a finer measurement of overall device power consumption.

Accordingly, and in view of the points asserted above, it is respectfully requested that the rejection of claim 1 be withdrawn.

With respect to claims 2-8, these claims depend from claim 1 and add further limitations that are neither anticipated nor made obvious by Mittal, Brock, Browning, or a combination of the noted references. Accordingly, Applicant respectfully requests that the Examiner withdraw the rejections of claims 2 and 6-8.

The Examiner also rejected claims 9 and 14 of the same basis as was set forth in the rejection of claim 1. Applicant notes that both claims 9 and 14 contain substantially similar limitations as claim 1 directed towards dynamically indicating how much power a respective functional unit is consuming, which have been argued above as being allowable over Mittal, Brock, and Browning. Therefore, it is requested that the rejections of claims 9 and 14 be withdrawn as well.

With respect to claims 10-13, these claims depend from claim 9 and add further limitations that are neither anticipated nor made obvious by Mittal, Brock, Browning, or a combination of the noted references. Accordingly, Applicant respectfully requests that the Examiner withdraw the rejections of claims 10-13.

With respect to claims 15-22, these claims depend from claim 14 and add further limitations that are neither anticipated nor made obvious by Mittal, Brock, Browning, or a combination of the noted references. Accordingly, Applicant respectfully requests that the Examiner withdraw the rejections of claims 15-22.

CONCLUSIONS

Applicant believes this to be a complete response to all of the issues raised in the instant office action and further submits, in view of the amendments and arguments advanced above, that claims 1-22 are in condition for allowance. Reconsideration of the rejections is requested, and allowance of the claims is solicited.

Applicant also notes that any amendments made by way of this response, and the observations contained herein, are made solely for the purpose of expediting the patent application process in a manner consistent with the PTO's Patent business Goals (PBG), 65 Fed. Reg. 54603 (September 8, 2000), and are furthermore made without prejudice to Applicant under this or any other jurisdictions. It is moreover asserted that insofar as any subject matter might otherwise be regarded as having been abandoned or effectively disclaimed by virtue of amendments made herein and/or incorporated in attachments submitted with this response, Applicants wishes to reserve the right and hereby provides notice of intent to restore such subject matter and/or file a continuation application in respect thereof.

Applicant earnestly requests that the Examiner contact the undersigned practitioner by telephone if the Examiner has any questions or suggestions concerning this amendment, the application, or allowance of any claims thereof.

Respectfully submitted,
HUFFMAN PATENT GROUP, LLC

/Richard K. Huffman/

By: _____

RICHARD K. HUFFMAN, P.E.
Registration No. 41,082
Tel: (719) 575-9998

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Date: _____